National Aeronautics and Space Administration

Small Business Innovation Research
Small Business Technology TRansfer

Finding Opportunities within the NASA Mission Directorates

Robert Jones, ARMD
Keith Woodman, HEOMD & STMD
Damian Taylor, STMD
Ramsey Smith, Ph.D., SMD

January 11, 2017

Aeronautics Research Mission Directorate (ARMD)

- NASA's Aeronautics Research Mission Directorate (ARMD) expands the boundaries of aeronautical knowledge for the benefit of the Nation and the broad aeronautics community, which includes the Agency's partners in academia, industry, and other government agencies.
- ARMD is conducting high-quality, cutting-edge research that will lead to revolutionary concepts, technologies, and capabilities that enable radical change to both the airspace system and the aircrafts that fly within it, facilitating a safer, more environmentally friendly, and more efficient air transportation system.
- At the same time, we are ensuring that aeronautics research and critical core competencies continue to play a vital role in support of NASA’s goals for both manned and robotic space exploration.

https://www.nasa.gov/aeroresearch

NASA Aeronautics – 6 Strategic Thrusts

Safe, Efficient Growth in Global Operations
- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
- Achieve a low-boom standard

Ultra-Efficient Commercial Vehicles
- Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
- Characterize drop-in alternative fuels and pioneer & low-carbon propulsion technology &

Real-Time System-Wide Safety Assurance
- Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
- Develop high impact aviation autonomy applications

Aeronautics Programs

Advanced Air Vehicle Program

Innovative design concepts developed by AAVP for advanced vehicles integrate multiple, simultaneous vehicle performance considerations that focus on fuel burn, noise, emissions and intrinsic safety. The goal: to enable new aircraft to fly safer, faster, cleaner, quieter, and use fuel far more efficiently.

The goal of AOSP-developed NextGen methods and means is to provide advanced levels of automated support to air navigation service providers and aircraft operators for reduced air travel times and air travel-related delays, and to insure greater safety in all weather conditions. By moving key concepts and technologies from the laboratory into the field, AOSP helps to make air travel as safe and efficient as possible – today as well as tomorrow – to directly benefit the flying public.

The objective of the IASP is to conduct flight oriented, integrated, system-level research and technology development that supports the flight research needs across the ARMD strategic thrusts, the programs and their projects.

Cultivates multi-disciplinary, revolutionary concepts to enable aviation transformation. Focus is on sharply focused research, and also provides flexibility for innovators to explore technology feasibility and provide the knowledge base for radical transformation.

ARMD Programs with Strategic Thrusts

Mission Programs

Airspace Operations and Safety Program (AOSP)

- Safe, Efficient Growth in Global Operations
- Real-Time System-Wide Safety Assurance
- Assured Autonomy for Aviation Transformation

Advanced Air Vehicles Program (AAVP)

- Ultra-Efficient Commercial Vehicles
- Innovation in Commercial Supersonic Aircraft
- Transition to Low-Carbon Propulsion
- Assured Autonomy for Aviation Transformation (future)

Integrated Aviation Systems Program (IASP)

- Flight Research-Oriented Integrated, System-Level R&T supporting all six thrusts
- X-Planes/Test Environment

Seedling Program

Transformative Aeronautics Concepts Program (TAC)

- High-risk, leap-frog ideas supporting all six thrusts
- Critical cross-cutting tool and technology development
- Assured Autonomy for Aviation Transformation

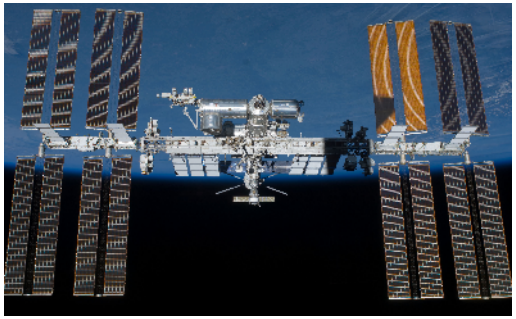
Human Exploration Mission Directorate (HOEMD)

- The Human Exploration and Operations (HEO) Mission Directorate provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit.
- HEO also oversees low-level requirements development, policy, and programmatic oversight.
- The International Space Station, currently orbiting the Earth with a crew of six, represents the NASA exploration activities in low-Earth orbit. Exploration activities beyond low-Earth orbit include the management of Commercial Space Transportation, Exploration Systems Development, Human Space Flight Capabilities, Advanced Exploration Systems, and Space Life Sciences Research & Applications.
- The directorate is similarly responsible for Agency leadership and management of NASA space operations related to Launch Services, Space Transportation, and Space Communications in support of both human and robotic exploration programs.

https://www.nasa.gov/directorates/heo

Opportunities to work with HEOMD

- www.nasa.gov/directorates/heo/index.html
- Programs
  - Space Launch System
  - Orion Spacecraft
  - Ground Systems Development
  - Advanced Exploration Systems
  - Space Life and Physical Sciences Research and Applications
  - Human Research Program
  - International Space Station
  - Launch Services
  - Space Communications and Navigation (SCaN)



HEOMD 2017 Topics & Subtopics

Topic/ Subtopic	Topic/Subtopic Title
H1	**In-Situ Resource Utilization (ISRU)**
H1.01	Mars Atmosphere Acquisition, Separation, and Conditioning for ISRU
H1.02	Mars Soil Acquisition and Processing for In Situ Water
H2	**Small Payloads for Lunar Missions**
H2.01	Lunar Resources
H3	**Habitation Systems**
H3.01	Habitat Outfitting
H3.02	Environmental Monitoring for Spacecraft Cabins
H3.03	Environmental Control and Life Support
H3.04	Logistics Reduction
H4	**Extra-Vehicular Activity (EVA)**
H4.01	Damage Tolerant Lightweight Pressure Structures
H4.02	Small, Accurate Oxygen Compatible Gas Flow Meter for Suit Operations
H4.03	Sensors to Measure Space Suit Interactions with the Human Body

Topic/ Subtopic	Topic/Subtopic Title
H5	**Lightweight Structures and Materials**
H5.01	Mars Surface Solar Array Structures
H5.02	Hot Structure Entry Control Surface Technology
H6	**Autonomous Systems**
H6.01	Integrated System Health Management for Sustainable Habitats
H6.02	Resilient Autonomous Systems
H6.03	Spacecraft Autonomous Agent Cognitive Architectures for Human Exploration
H7	**In-Space Manufacturing**
H7.01	In-Space Manufacturing of Electronics and Avionics
H7.02	In-Space Manufacturing of Precision Parts
H8	**ISS Utilization and Microgravity Research**
H8.01	ISS Utilization and Microgravity Research

HEOMD 2017 Topics & Subtopics

Topic/ Subtopic	Topic/Subtopic Title
H9	**Space Communications and Navigation**
H9.01	Long Range Optical Telecommunications
H9.02	Intelligent Communication Systems
H9.03	Flight Dynamics and Navigation Technology
H9.04	Advanced RF Communications
H9.05	Transformational/Over-the-Horizon Communications Technology
H10	**Ground and Launch Processing**
H10.01	Advanced Propulsion Systems Ground Test Technology
H10.02	Improved Operations via Interface Design
H10.03	Cryogenic Purge Gas Recovery and Reclamation
H11	**Radiation Protection**
H11.01	Radiation Shielding Technologies for Human Protection
H12	**Human Research and Health Maintenance**
H12.01	Radioprotectors and Mitigators of Space Radiation-induced Health Risks
H12.02	Advanced Model-based Adaptive Interfaces and Augmented Reality

Space Technology Mission Directorate (STMD)

- The Space Technology Mission Directorate (STMD) enables a new class of missions by drawing on talent from the NASA workforce, academia, small businesses, and the broader space enterprise to deliver innovative solutions that dramatically improve technological capabilities for NASA and the Nation.
- The rapid development and infusion of new technologies and capabilities are critical components to advancing the Nation's future in space. These activities fuel an emerging aerospace economy and build upon the space technology needs of other government agencies, as well as the overall aerospace enterprise.
- NASA supports these objectives and contributes to the demands of larger national technology goals by investing in Space Technology.

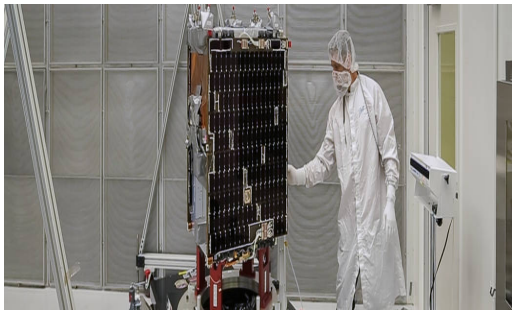
https://www.nasa.gov/directorates/spacetech/home

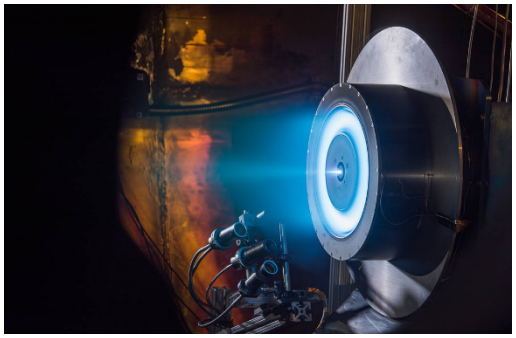
NASA's Technology Roadmaps

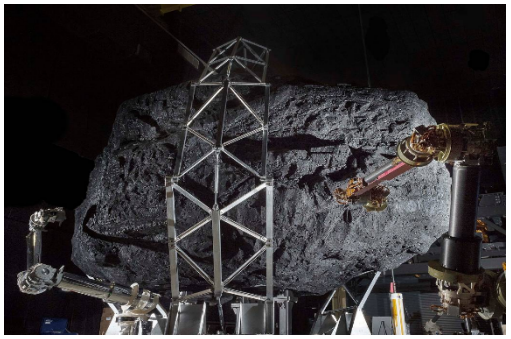
https://www.nasa.gov/offices/oct/home/roadmaps/index.html

Opportunities to work with STMD

- https://www.nasa.gov/directorates/spacetech/home/index.html
- Programs
  - Centennial Challenges
  - Center Innovation Fund
  - Flight Opportunities
  - Game Changing Development (GCD)
  - NASA Innovative Advanced Concepts (NIAC)
  - Prizes and Challenges
  - Regional Economic Development
  - SBIR/STTR
  - Small Spacecraft Technology Program
  - Space Technology Research Grants
  - Technology Demonstration Program
  - Technology Transfer







STMD 2017 Topics & Subtopics

Topic/ Subtopic	Topic/Subtopic Title
Z1	**Power and Energy Storage**
Z1.01	High Power, High Voltage Electronics
Z1.02	Surface Energy Storage
Z1.03	Surface Power Generation
Z2	**Thermal Management**
Z2.01	Thermal Management
Z3	**Advanced Manufacturing**
Z3.01	In-Situ Sensing of Additive Manufacturing Processes for Safety-Critical Aerospace Applications
Z3.02	Advanced Metallic Materials and Processes Innovation
Z4	**Lightweight Materials, Structures, Assembly and Construction**
Z4.01	In-Space Structural Assembly and Construction

Topic/ Subtopic	Topic/Subtopic Title
Z5	**Robotic Systems for Space Exploration**
Z5.01	Payload Technologies for Free-Flying Robots
Z5.02	Robotic Systems - Mobility Subsystems
Z6	**Avionics Technology**
Z6.01	High Performance Space Computing Technology
Z7	**Entry, Descent, and Landing Systems**
Z7.01	Supersonic Parachute Inflation Materials Testing, and Instrumentation
Z7.02	Deployable 3D Woven Thermal Protection Materials
Z7.03	Deployable Aerodynamic Decelerator Technology
Z8	**Small Spacecraft Technologies**
Z8.01	Small Spacecraft Propulsion Systems
Z8.02	Small Spacecraft Communication Systems
Z8.03	Small Spacecraft Power and Thermal Control
Z8.04	Small Spacecraft Structures, Mechanisms, and Manufacturing
Z8.05	Small Spacecraft Avionics and Control

STMD 2017 Topics & Subtopics

Topic/ Subtopic	Topic/Subtopic Title
Z9	**Small Spacecraft Launch Technologies and Demonstration**
Z9.01	Small Launch Vehicle Technologies and Demonstrations
Z10	**In-Space Propulsion Technologies**
Z10.01	Cryogenic Fluid Management
Z10.02	Methane In-Space Propulsion
Z10.03	Nuclear Thermal Propulsion (NTP)
Z11	**Non-Destructive Evaluation Technologies**
Z11.01	NDE Sensors
Z11.02	NDE Simulation and Analysis

National Aeronautics and
Space Administration

Space Technology Research Grants (STRG) Program Overview

Space Technology Mission Directorate

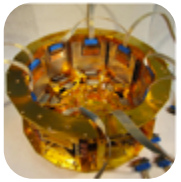
Claudia Meyer,
Program Executive
claudi.m.meyer@nasa.gov

January 2017

Space Technology Research Grants
Opportunities to Propose

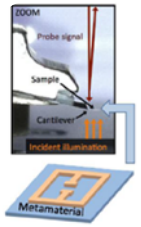
Engage Academia: tap into spectrum of academic researchers, from graduate students to senior faculty members, to examine the theoretical feasibility of ideas and approaches that are critical to making science, space travel, and exploration more effective, affordable, and sustainable.



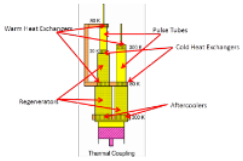

NASA Space Technology Research Fellowships

- Graduate student research in space technology; research conducted on campuses and at NASA Centers and not-for-profit R&D labs



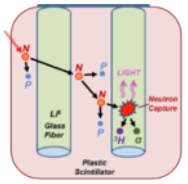
Early Career Faculty

- Focused on supporting outstanding faculty researchers early in their careers as they conduct space technology research of high priority to NASA's Mission Directorates

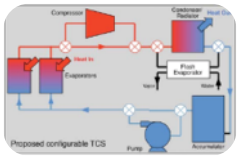


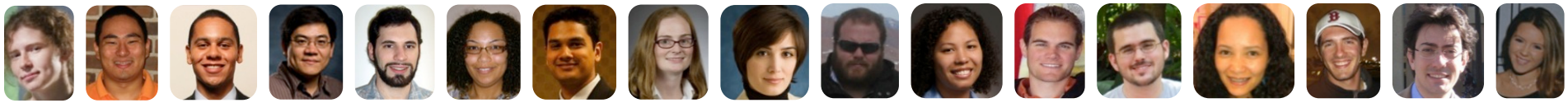
Early Stage Innovations

- University-led, possibly multiple investigator, efforts on early-stage space technology research of high priority to NASA's Mission Directorates
- Paid teaming with other universities, industry and non-profits permitted



Reinvigorate the pipeline of high-risk/high-payoff low-TRL space technologies





STRG Opportunities to Propose NSTRF

Eligibility Requirements for NSTRF17

1. Pursuing or seeking to pursue advanced degrees directly related to space technology.
2. Are U.S. citizens or permanent residents of the U.S.
3. Are or will be enrolled in a full-time master's or doctoral degree program at an accredited U.S. university in fall 2017.
4. Are early in their graduate careers.

NSTRF17: http://tinyurl.com/NSTRF2017.
NSTRF16: http://tinyurl.com/NSTRF2016.
NSTRF15: http://tinyurl.com/NSTRF2015.
NSTRF14: http://tinyurl.com/NSTRF14.
NSTRF13: http://tinyurl.com/NSTRF13.
NSTRF12: http://tinyurl.com/NSTRF12-OCT.
NSTRF11: http://tinyurl.com/NSTRF11-OCT.

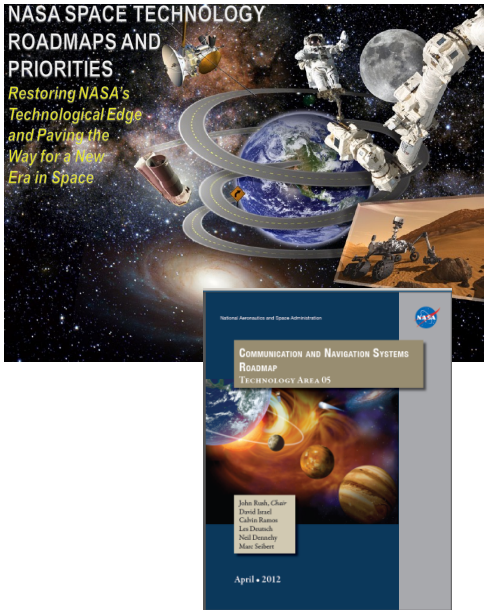
Application Components

1. Proposal Cover Page (Program Specific Data Questions)
2. Personal Statement
3. Project Narrative
4. Degree Program Schedule
5. Curriculum Vitae
6. Transcripts
7. GRE General Test Scores
8. Three Letters of Recommendation

Award Value

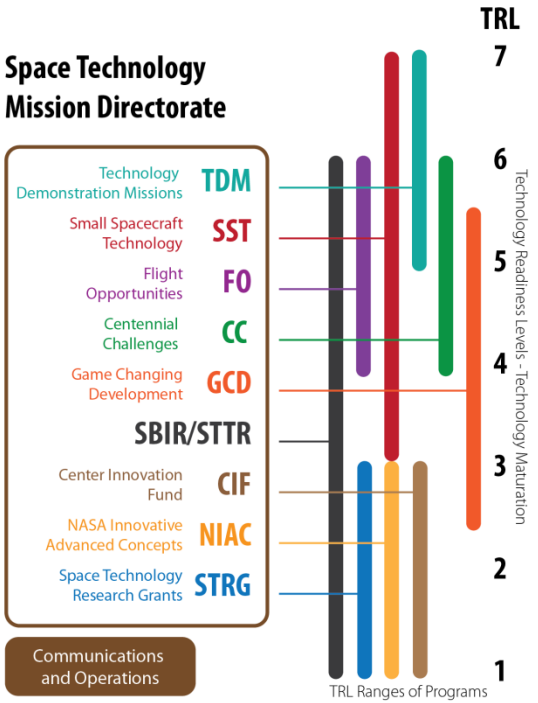
Fellowship Budget Category	Max value
Student Stipend	$36,000
Faculty Advisor Allowance	$10,000
Visiting Technologist Experience Allowance	$10,000
Health Insurance Allowance	$1,000
Tuition and Fees Allowance	$17,000
TOTAL	$74,000

STRG Opportunities to Propose ECF and ESI



Technical Characteristics:

- Unique, disruptive or transformational space technologies
- Low TRL
- Specific topics tied to Technology Area Roadmaps
- Big impact at the system level: performance, weight, cost, reliability, operational simplicity or other figures of merit associated with space flight hardware or missions



http://tinyurl.com/NASAECF http://tinyurl.com/NASA-14ECF http://tinyurl.com/NASA-15ECF http://tinyurl.com/NASA-16ECF
http://tinyurl.com/NASAESI http://tinyurl.com/NASA-13ESI http://tinyurl.com/NASA-14ESI www.tinyurl.com/NASA-15ESI http://tinyurl.com/NASA-16ESI

Eligibility Summary:

Both ECF and ESI proposals must be submitted by accredited U.S. universities

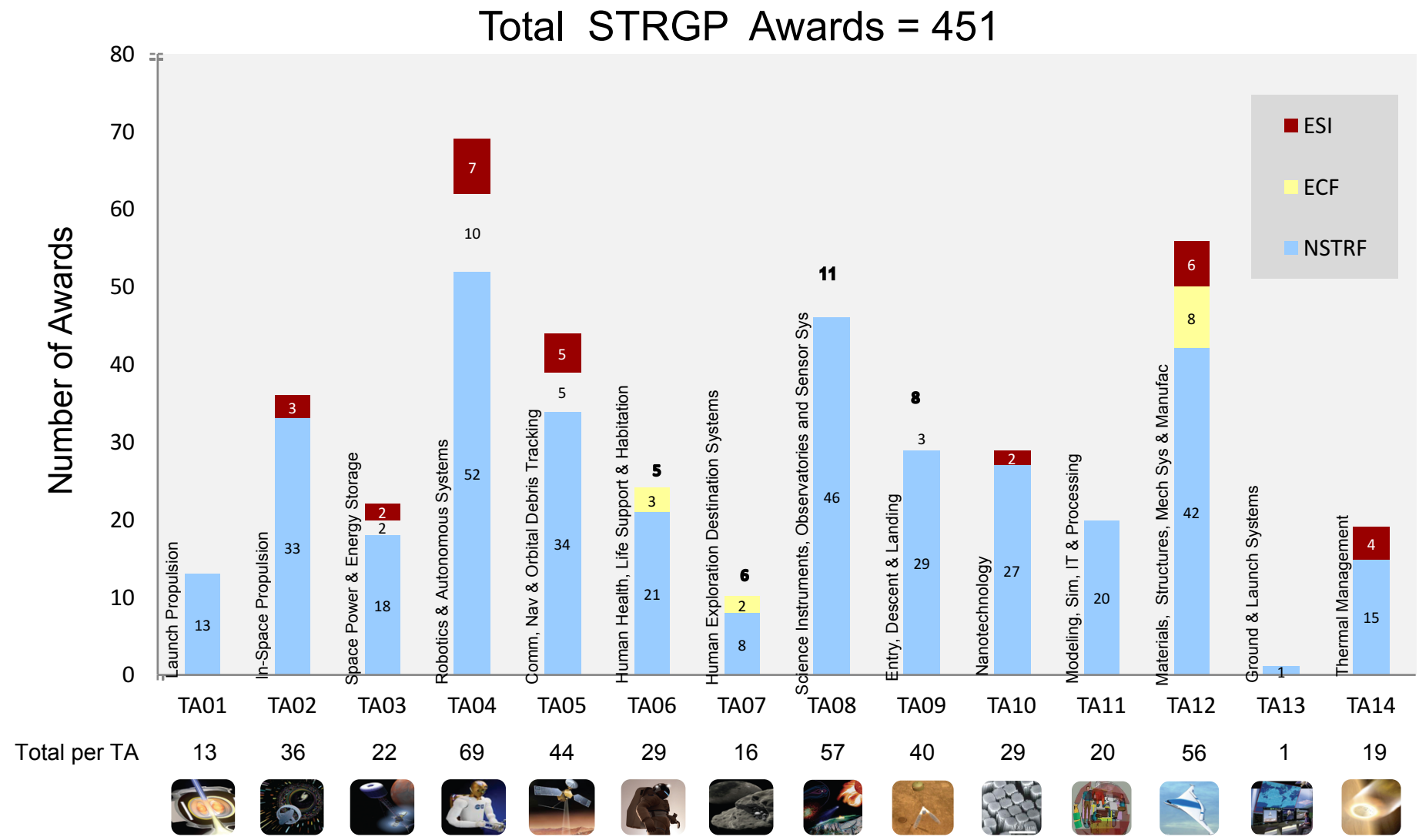
Early Career Faculty

- PI must be recent Ph.D. (last 7 years)
- Untenured assistant professor and on tenure track
- U.S. citizen or permanent resident
- No co-investigators

Early Stage Innovations

- PI must be from proposing university
- Co-investigators are permitted
- ≥ 50% of the proposed budget must go to the proposing university
- ≥ 70% of the proposed budget must go to universities

STRG Portfolio - Awards To-Date
Awards by Technology Area



STRG Highlights and Plans

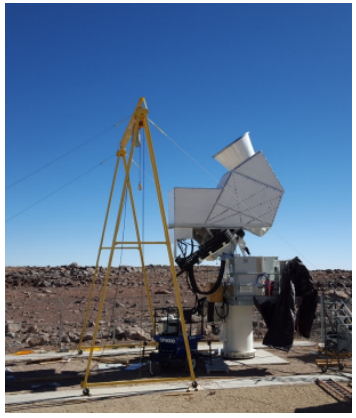
TA14- Corey Kruse, U Nebraska Lincoln: Using Femtosecond Laser Processing to improve heat transfer on bare stainless steel and copper surfaces by nearly 7x over traditional materials. .

TA06- Heather Hava, CU Boulder: Developed in situ food (plant) production systems for space exploration, relevant for long duration missions; Completed the design of an intelligent pot (SmartPOT) that can be remotely monitored and controlled.

TA12- Scott Zavada, U Michigan: established the viability of using an in situ polymerizable liquid as an autonomic healing layer within a rigid structure, which was validated by ballistics testing.

STRG is impacting all Technology Areas. Here are some examples.

TA04- Jennifer King, Carnegie Mellon: Successfully expanded the types of tasks that can be performed by robots while reducing the need to hard-code task-specific action sequences. The algorithms use simple physics models (including estimates of friction, mass, etc.) to enable a robot to autonomously plan its interactions with the environment and perform manipulation tasks beyond just pick and place.

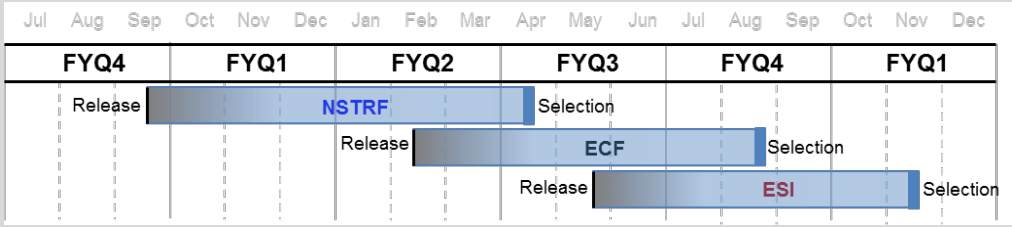


TA08- Kathleen Harrington, Johns Hopkins: successfully installed and operated Variable-delay Polarization Modulators (VPMs) on the Cosmology Large Angular Scale Surveyor (CLASS) telescope in Atacama, Chile.

Recent Milestones

Solicitation	Date
NSTRF	11/3/2016: NSTRF17 applications due
ECF	10/1/16: ECF16 awards in place
ESI	12/2/16: ESI16 announcement

Annual Solicitation Schedule



NASA Innovative Advanced Concepts (NIAC) Program

Space Technology
Mission Directorate

January 11, 2017

Jason Derleth
Program Executive, NIAC
hq-niac@mail.nasa.gov

What is NIAC?

NASA Innovative Advanced Concepts

NASA Innovative Advanced Concepts

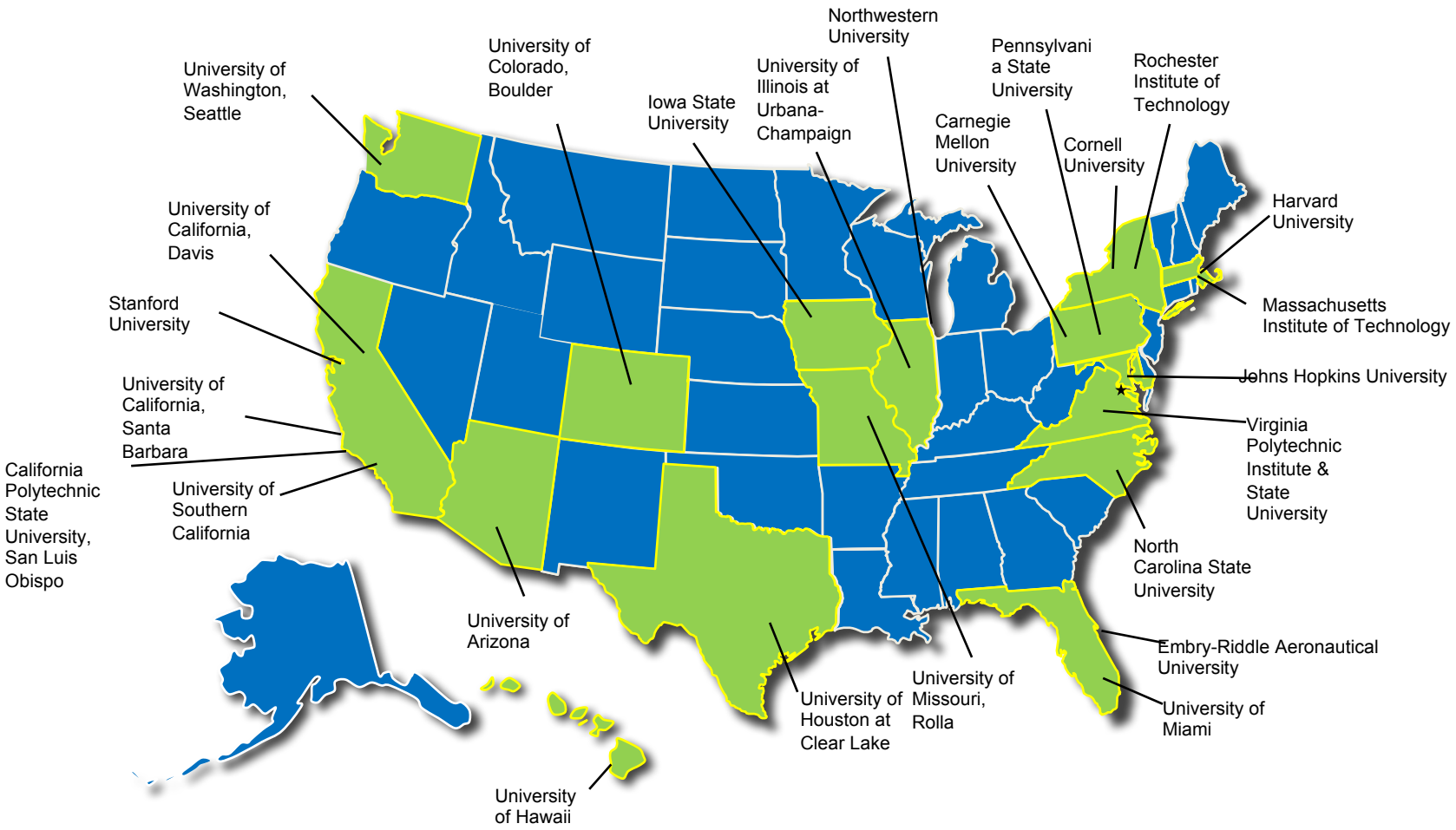
A program to support early studies of innovative, yet credible, visionary concepts that could one day "change the possible" in aerospace.

NIAC Awards, Scope, Criteria

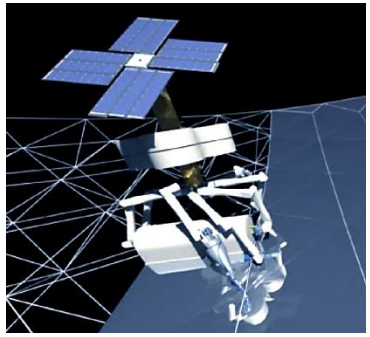
- NIAC awards support 2 phases of study:
  - **Phase I**: up to $125K, ~9 months, for concept definition and initial analysis in a mission context
    - **Proposal Submission & Selection Process**: Two-step Process; Step A is fully- open; Step B by Invitation only; Independent Peer Review. (https://www.nasa.gov/directorates/spacetech/niac/niac-phase-I-solicitation)
  - **Phase II**: up to $500K, 2 years, for further development of most promising Phase I concepts, comparative mission analysis, pathways forward
  - **Eligibility:** All categories of U.S organizations may apply. Non-U.S. organizations may partner in, or lead, NIAC studies on a no-exchange of funds basis, and subject to NASA's policy on foreign participation. **How to Apply**: (https://www.nasa.gov/feature/how-to-apply-to-niac)
  - **Goal:** Early studies of visionary aerospace architecture or mission concept
  - **Technology Readiness Level (TRL):** TRL 2 or lower at start of award
  - **NIAC Key Dates:** FY17 PhI Selections – 28 Mar '17 (Target); FY17 PhII NRA Released - 8 Dec '16; FY17 PhII Proposals Due – 3 Feb '17 (Target); (https://www.nasa.gov/content/key-dates-and-solicitations)
- Scope of NIAC Phase I Studies:
  - Aerospace architecture or mission concepts (not focused tech.)
  - **Exciting**: offering a potential breakthrough or revolutionary improvement
  - **Unexplored**: novel, with basic feasibility and properties unclear
  - **Credible**: sound scientific/engineering basis and plausible implementation
- NIAC proposal evaluation criteria:
  - **Potential of the Concept** (all scope elements above, especially exciting)
  - **Strength of the Approach** (research objectives, technical issues, suitability of team and cost)
  - **Benefits of the Study** (concept definition, mission analysis, wider benefits, scientific/engineering contributions, notably new/different/inspiring)

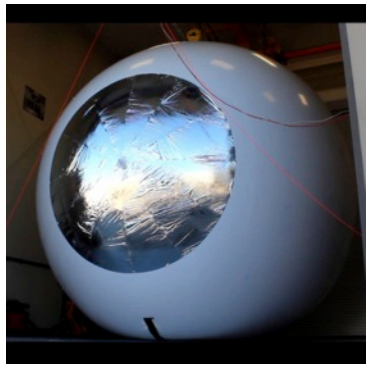
NIAC Educational Institutions

UNIVERSITY PARTNERS: Inspiring Our Nation's Innovators



NIAC Awards & Successes





Notable Awards & Successes of NIAC Fellows

$100M institute created for NIAC concept:
Prof. Philip Lubin, University of California, Santa Barbara
Private Funding - Directed energy interstellar work

Prof. Chris Walker, University of Arizona
was testing his 10 Meter Sub-Orbital Large Balloon Reflector (LBR) in Antarctica with NASA

NIAC Fellow and NEC Member, Prof. Penny Boston was selected as NASA's new Director for Astrobiology at NASA ARC, effective May 31st 2016

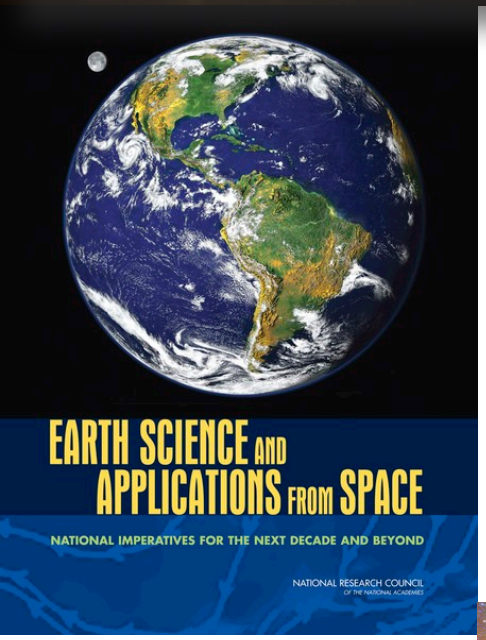
Prof. Behrohk Khoshnevis, University of Southern California- Space Based Manufacturing First place award at the NASA In-Situ Materials Challenge

Space Mission Directorate (SMD)

- The Science Mission Directorate develops and operates an overall program of science and exploration. Objectives include the following:
  - (1) study planet Earth from space to advance scientific understanding and meet societal needs;
  - (2) understand the Sun and its effects on Earth and the Solar System;
  - (3) advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space and
  - (4) discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

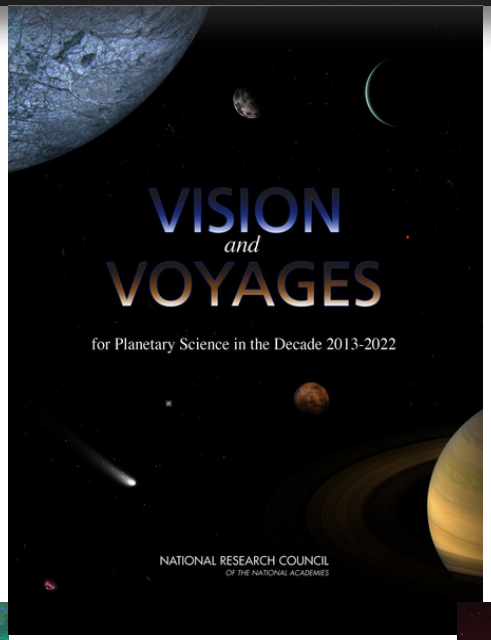
https://science.nasa.gov

Science Divisions



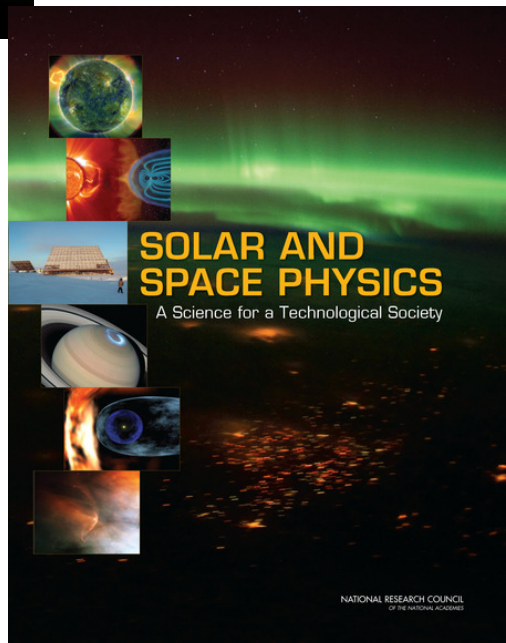
Earth Science

Astrophysics



Heliophysics

Planetary Science



The Goals and Needs of SMD

SMD research and technology development must have science traceability to external roadmaps, reports and surveys:

- Strategy Documents
- Decadal Surveys
  - Every ten years, the four science communities gather panels of experts to set community-wide priorities for the coming decade. These surveys are facilitated by the National Academies and commissioned by the Federal agencies. The most recent surveys were completed between 2010 and 2013.

SMD Funding Pathways

SMD BY THE NUMBERS

Spacecraft
105 missions*
88 spacecraft

CubeSats
12 science missions*
11 technology demonstrations

Balloon Payloads
13 science payloads
13 piggyback/
educational payloads

Sounding Rocket Flights
14 science missions
3 technology/educational
missions

Earth-Based Investigations
25 major airborne missions
8 global networks

Technology Development
~$400M invested annually

Research
10,000+ U.S. scientists funded
3,000+ competitively selected awards
~$600M awarded annually

*117 space-based missions

SMD Solicitations

https://science.nasa.gov/researchers/sara/grant-solicitations

- Many solicitations are located at: https://nspires.nasaprs.com
  - important group of Solicitations: Research Opportunities in Earth and Space Science (ROSES)*
  - Set up NSPIRES account in advance and become familiar with the submission process.

*Note: Previous solicitations are available

Example Funding Opportunities

- Earth Science
  - The Instrument Incubator Program funds technology development (IIP)
- Planetary Science
  - Concepts for Ocean worlds Life Detection Technology (COLD-Tech)
- Astrophysics
  - Astrophysics Research and Analysis program (APRA)
- Heliophysics
  - Heliophysics Supporting Research (H-SR)

How To Contact Us

- **Online**: www.sbir.nasa.gov
- **NASA Help Desk**: 301.937.0888
- **Email**: sbir@reisystems.com